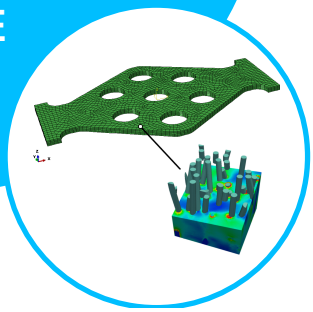
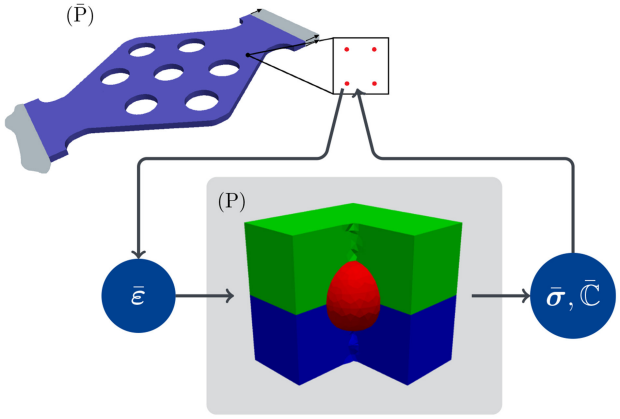
SimTech

M.Sc. thesis
Projektarbeit
Forschungsmodul
SimTech

Multiscale material simulations using the FE-FFT method with the coupling library preCICE





For many multiscale material simulations, macro(coarse)-scale simulations need to be complemented with micro-scale simulations to incorporate the effects of micro-structures in the material. This link is especially important when highly heterogeneous materials are used. Both scales need to be solved in tandem and in an efficient manner. In this thesis, mechanical geometry under a static or dynamic load will be simulated on the macro scale. This will be done using the finite element library FEniCSx. At each compute point of the macro scale, a micro scale problem will be solved to get the constitutive response necessary to augment the macro scale. These micro scale problems are solved in effect to resolve the underlying micro structure of the material. The micro scale problems will be solved using an existing FFT solver called Fourier-accelerated nodal solvers (FANS). The coupling between the macro scale and the micro scale simulations will be done with the coupling library preCICE [a] and an additional software component called the Micro Manager [b].

[a] https://precice.org/
[b] https://github.com/precice/micro-manager

Work packages

- Setup macro scale problem using the finite element library FEniCSx
- Turning FANS (micro-scale code) into a usable and sustainable software package
- Building the macro-micro coupling with preCICE and the Micro Manager
- Validating and verifying the coupling using a realistic FE2 simulation scenario

Technical requirements

- Working knowledge in C++ and Python
- Basic know-how of numerical analysis and the finite element method
- Interest in working with open-source software

Contact
Ishaan Desai
ishaan.desai@ipvs.uni-stuttgart.de

Contact
Sanath Keshav
keshav@mib.uni-stuttgart.de

April 17, 2023